

# MEMORY Mobile FCRAM™

CMOS

## 16 Mbit (1 M word × 16 bit) Mobile Phone Application Specific Memory

### MB82D01181E-60L

#### ■ DESCRIPTION

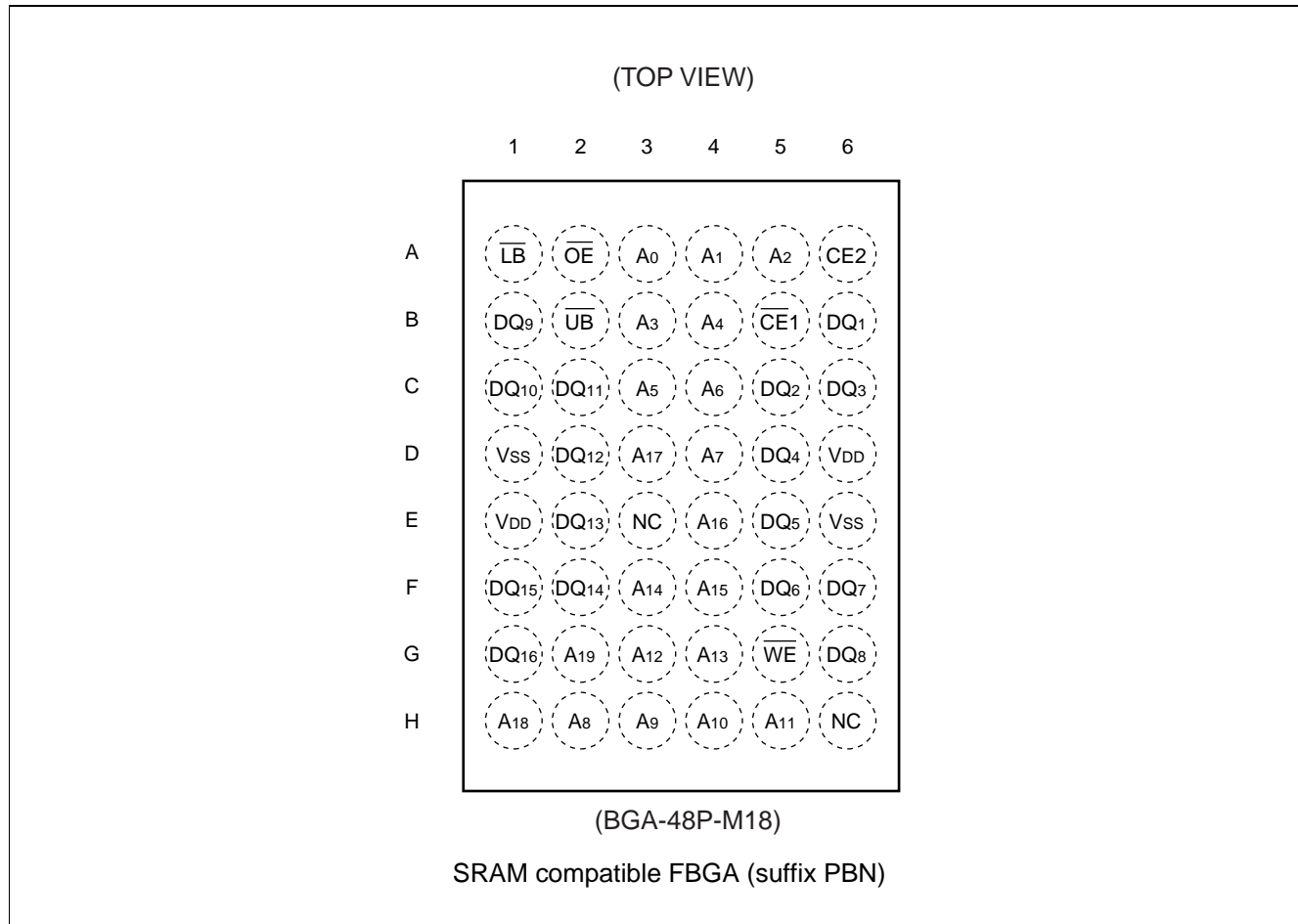
MB82D01181E is a Fast Cycle Random Access Memory (FCRAM) with asynchronous Static Random Access Memory (SRAM) interface containing 16,777,216 storages accessible in a 16-bit format. MB82D01181E is suited for mobile applications such as Cellular Handset and PDA.

Note: FCRAM is a trademark of Fujitsu Limited, Japan.

#### ■ FEATURES

- Asynchronous SRAM Interface
- 1 M word × 16 bit Organization
- Low-voltage Operating Conditions :  $V_{DD} = 2.3 \text{ V to } 3.5 \text{ V}$
- Wide Operating Temperature :  $T_A = 0 \text{ }^\circ\text{C to } +70 \text{ }^\circ\text{C}$
- Read/Write Cycle Time :  $t_{RC} = t_{WC} = 70 \text{ ns Min}$
- Fast Random Access Time :  $t_{AA} = t_{CE} = 60 \text{ ns Max}$
- Active current :  $I_{DDA1} = 20 \text{ mA Max}$
- Standby current :  $I_{DDs1} = 100 \text{ } \mu\text{A Max (} V_{DD} \leq 3.1 \text{ V)}$
- Power down current :  $I_{DDP} = 10 \text{ } \mu\text{A Max}$
- Byte Control
- Shipping Form : Wafer/Chip, 48-pin plastic FBGA

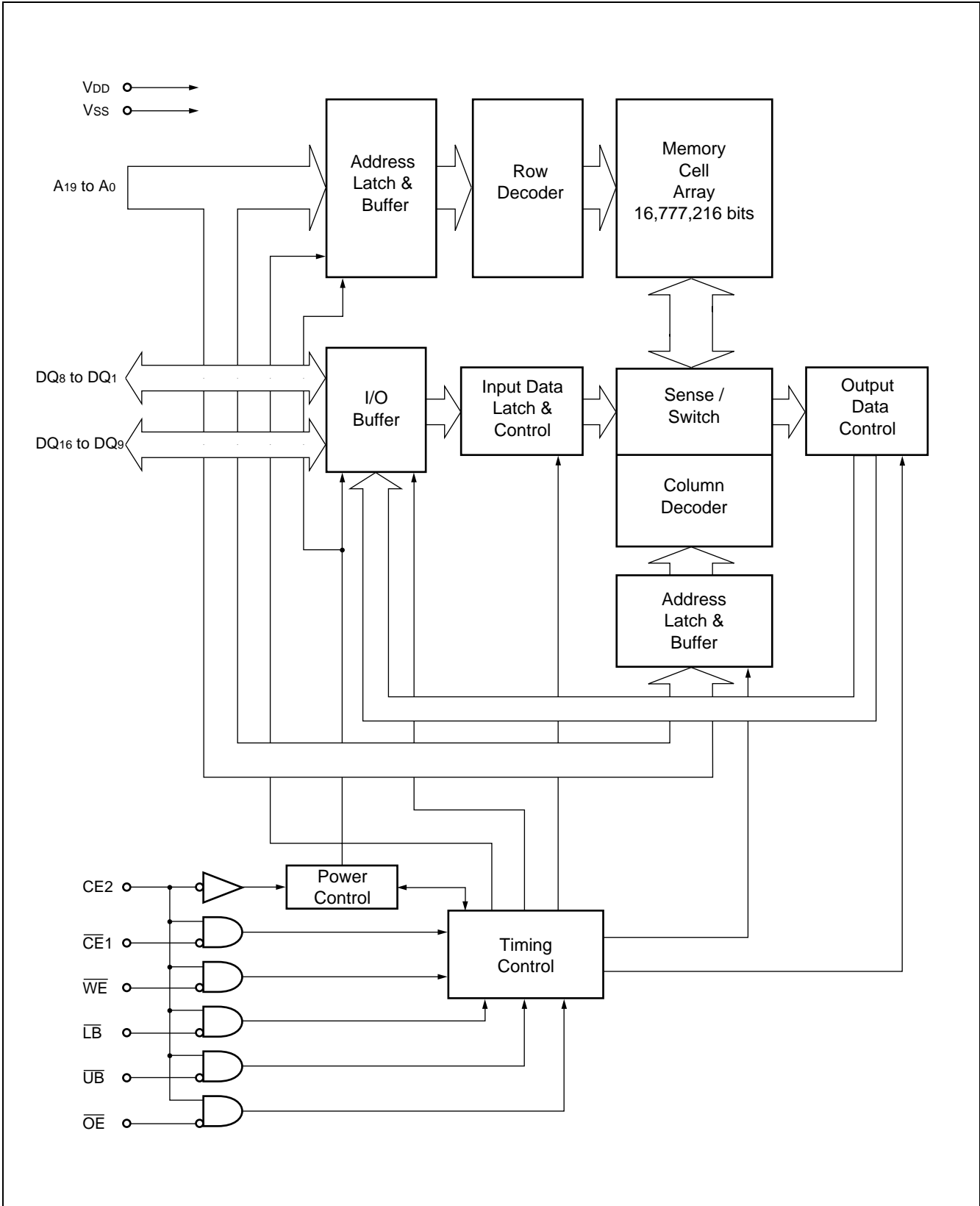
## ■ PIN ASSIGNMENT



## ■ PIN DESCRIPTION

Pin Name	Description
A <sub>19</sub> to A <sub>0</sub>	Address Input
CE1	Chip Enable (Low Active)
CE2	Chip Enable (High Active)
WE	Write Enable (Low Active)
OE	Output Enable (Low Active)
LB	Lower Byte Control (Low Active)
UB	Upper Byte Control (Low Active)
DQ <sub>8</sub> to DQ <sub>1</sub>	Lower Byte Data Input/Output
DQ <sub>16</sub> to DQ <sub>9</sub>	Upper Byte Data Input/Output
V <sub>DD</sub>	Power Supply
V <sub>SS</sub>	Ground
NC	No Connection

■ BLOCK DIAGRAM



## ■ FUNCTION TRUTH TABLE

Mode	CE2	$\overline{CE1}$	$\overline{WE}$	$\overline{OE}$	$\overline{LB}$	$\overline{UB}$	A <sub>19</sub> to A <sub>0</sub>	DQ <sub>8</sub> to DQ <sub>1</sub>	DQ <sub>16</sub> to DQ <sub>9</sub>	I <sub>DD</sub>	Data Retention	
Standby (Deselect)	H	H	X	X	X	X	X	High-Z	High-Z	I <sub>DDs</sub>	Yes	
Output Disable* <sup>1</sup>		L	H	H	X	X	*3	High-Z	High-Z	I <sub>DDA</sub>		
No Read			H	L	L	H	H	Valid	High-Z			High-Z
Read (Upper Byte)						H	L	Valid	High-Z			Output Valid
Read (Lower Byte)						L	H	Valid	Output Valid			High-Z
Read (Word)						L	L	Valid	Output Valid			Output Valid
No Write			L	H	H	H	H	Valid	Invalid			Invalid
Write (Upper Byte)						H	L	Valid	Invalid			Input Valid
Write (Lower Byte)						L	H	Valid	Input Valid			Invalid
Write (Word)						L	L	Valid	Input Valid			Input Valid
Power Down * <sup>2</sup>	L		X	X	X	X	X	X	High-Z		High-Z	I <sub>DDP</sub>

Note : L = V<sub>IL</sub>, H = V<sub>IH</sub>, X = either V<sub>IL</sub> or V<sub>IH</sub>, High-Z = High impedance

\*1 : Output disable mode should not be kept longer than 1 μs.

\*2 : Power down mode can be entered from standby state and all DQ pins are in High-Z state.

\*3 : Can be either V<sub>IL</sub> or V<sub>IH</sub> but must be valid before read or write.

## ■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Unit
		Min	Max	
Supply Voltage *	$V_{DD}$	-0.5	+3.6	V
Input Voltage *	$V_{IN}$	-0.5	+3.6	V
Output voltage *	$V_{OUT}$	-0.5	+3.6	V
Short Circuit Output Current	$I_{OUT}$	-50	+50	mA
Storage Temperature	$T_{STG}$	-55	+125	°C

\* : All voltages are referenced to  $V_{SS}$ .

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

## ■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Value		Unit
		Min	Max	
Supply Voltage *1, *2	$V_{DD(31)}$	3.1	3.5	V
	$V_{DD(27)}$	2.7	3.1	V
	$V_{DD(23)}$	2.3	2.7	V
	$V_{SS}$	0	0	V
High Level Input Voltage *1, *2, *3	$V_{IH(31)}$	$V_{DD} \times 0.8$	$V_{DD} + 0.2$ and $\leq 3.5$	V
	$V_{IH(23, 27)}$	$V_{DD} \times 0.8$	$V_{DD} + 0.2$	V
Low Level Input Voltage *1, *4	$V_{IL}$	-0.3	$V_{DD} \times 0.2$	V
Ambient Temperature	$T_A$	0	+70	°C

\*1 : All voltages are referenced to  $V_{SS}$ .

\*2 : This device supports three voltage ranges,  $V_{DD(31)}$ ,  $V_{DD(27)}$ , and  $V_{DD(23)}$  on identical device.  $V_{DD}$  range is divided into three ranges on the table due to  $V_{IH}$  varied according to  $V_{DD}$  supply voltage.

\*3 : Overshoot spec. ( $V_{IH(Max)} = V_{DD} + 1.0$  V, pulse width  $\leq 5.0$  ns)

\*4 : Undershoot spec. ( $V_{IL(Min)} = -1.0$  V, pulse width  $\leq 5.0$  ns)

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

## ■ PIN CAPACITANCE

(f = 1.0 MHz, T<sub>A</sub> = +25 °C)

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Address Input Capacitance	C <sub>IN1</sub>	V <sub>IN</sub> = 0 V	—	—	5	pF
Control Input Capacitance	C <sub>IN2</sub>	V <sub>IN</sub> = 0 V	—	—	5	pF
Data Input/Output Capacitance	C <sub>IO</sub>	V <sub>IO</sub> = 0 V	—	—	8	pF

## ■ DC CHARACTERISTICS

Parameter	Symbol	Conditions	Value		Unit	
			Min	Max		
Input Leakage Current	I <sub>LI</sub>	V <sub>SS</sub> ≤ V <sub>IN</sub> ≤ V <sub>DD</sub>	-1.0	+1.0	μA	
Output Leakage Current	I <sub>LO</sub>	V <sub>SS</sub> ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> , Output Disable	-1.0	+1.0	μA	
Output High Voltage Level	V <sub>OH(31)</sub>	V <sub>DD</sub> = V <sub>DD(31)</sub> Min, I <sub>OH</sub> = -0.5 mA	2.5	—	V	
	V <sub>OH(27)</sub>	V <sub>DD</sub> = V <sub>DD(27)</sub> Min, I <sub>OH</sub> = -0.5 mA	2.2	—	V	
	V <sub>OH(23)</sub>	V <sub>DD</sub> = V <sub>DD(23)</sub> Min, I <sub>OH</sub> = -0.5 mA	1.8	—	V	
Output Low Voltage Level	V <sub>OL</sub>	I <sub>OL</sub> = 1 mA	—	0.4	V	
V <sub>DD</sub> Power Down Current	I <sub>DDP</sub>	V <sub>DD</sub> = V <sub>DD</sub> Max, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , CE2 ≤ 0.2 V	—	10	μA	
V <sub>DD</sub> Standby Current	I <sub>DDS</sub>	V <sub>DD</sub> = V <sub>DD(31)</sub> Max, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , CE1 = CE2 = V <sub>IH</sub>	—	2.0	mA	
		V <sub>DD</sub> = V <sub>DD(27, 23)</sub> Max, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , CE1 = CE2 = V <sub>IH</sub>	—	1.0		
	I <sub>DDS1</sub>	V <sub>DD</sub> = V <sub>DD(31)</sub> Max, V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>DD</sub> - 0.2 V, CE1 = CE2 ≥ V <sub>DD</sub> - 0.2 V	—	150	μA	
		V <sub>DD</sub> = V <sub>DD(27, 23)</sub> Max, V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>DD</sub> - 0.2 V, CE1 = CE2 ≥ V <sub>DD</sub> - 0.2 V	—	100		
V <sub>DD</sub> Active Current	I <sub>DDA1</sub>	V <sub>DD</sub> = V <sub>DD</sub> Max, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , CE1 = V <sub>IL</sub> and CE2 = V <sub>IH</sub> , I <sub>OUT</sub> = 0 mA	t <sub>RC</sub> / t <sub>WC</sub> = Min	—	20	mA
			t <sub>RC</sub> / t <sub>WC</sub> = 1 μs	—	3.0	

- Notes:
- All voltages are referenced to V<sub>SS</sub>.
  - DC Characteristics are measured after following POWER-UP timing.
  - I<sub>OUT</sub> depends on the output load conditions.

## ■ AC CHARACTERISTICS

### (1) Read Operation

Parameter	Symbol	Value		Unit	Notes
		Min	Max		
Read Cycle Time	$t_{RC}$	70	1000	ns	*1, *2
$\overline{CE1}$ Access Time	$t_{CE}$	—	60	ns	*3
$\overline{OE}$ Access Time	$t_{OE}$	—	40	ns	*3
Address Access Time	$t_{AA}$	—	60	ns	*3, *5
$\overline{LB}$ , $\overline{UB}$ Access Time	$t_{BA}$	—	30	ns	*3
Output Data Hold Time	$t_{OH}$	5	—	ns	*3
$\overline{CE1}$ Low to Output Low-Z	$t_{CLZ}$	5	—	ns	*4
$\overline{OE}$ Low to Output Low-Z	$t_{OLZ}$	0	—	ns	*4
$\overline{LB}$ , $\overline{UB}$ Low to Output Low-Z	$t_{BLZ}$	0	—	ns	*4
$\overline{CE1}$ High to Output High-Z	$t_{CHZ}$	—	20	ns	*3
$\overline{OE}$ High to Output High-Z	$t_{OHZ}$	—	20	ns	*3
$\overline{LB}$ , $\overline{UB}$ High to Output Low-Z	$t_{BHZ}$	—	20	ns	*3
Address Setup Time to $\overline{CE1}$ Low	$t_{ASC}$	-5	—	ns	
Address Setup Time to $\overline{OE}$ Low	$t_{ASO}$	10	—	ns	
Address Invalid Time	$t_{AX}$	—	10	ns	*5
Address Hold Time from $\overline{CE1}$ High	$t_{CHAH}$	-5	—	ns	*6
Address Hold Time from $\overline{OE}$ High	$t_{OHAH}$	-5	—	ns	
$\overline{WE}$ High to $\overline{OE}$ Low Time for Read	$t_{WHOL}$	10	1000	ns	*7
$\overline{CE1}$ High Pulse Width	$t_{CP}$	10	—	ns	

\*1 : Maximum value is applicable if  $\overline{CE1}$  is kept at Low without any address change.

\*2 : Address should not be changed within minimum  $t_{RC}$ .

\*3 : The output load 50 pF with 50  $\Omega$  termination to  $V_{DD} \times 0.5$  V.

\*4 : The output load 5 pF without any other load.

\*5 : Applicable when  $\overline{CE1}$  is kept at Low.

\*6 :  $t_{RC}$  (Min) must be satisfied.

\*7 : If the actual value of  $t_{WHOL}$  is shorter than specified minimum value, the actual  $t_{AA}$  of following Read may become longer by the amount of subtracting actual value from specified minimum value.

## (2) Write Operation

Parameter	Symbol	Value		Unit	Notes
		Min	Max		
Write Cycle Time	$t_{WC}$	70	1000	ns	*1, *2
Address Setup Time	$t_{AS}$	0	—	ns	*2
$\overline{CE1}$ Write Pulse Width	$t_{CW}$	45	—	ns	*3
$\overline{WE}$ Write Pulse Width	$t_{WP}$	45	—	ns	*3
$\overline{LB}$ , $\overline{UB}$ Write Pulse Width	$t_{BW}$	45	—	ns	*3
$\overline{LB}$ , $\overline{UB}$ Byte Mask Setup Time	$t_{BS}$	-5	—	ns	*4
$\overline{LB}$ , $\overline{UB}$ Byte Mask Hold Time	$t_{BH}$	-5	—	ns	*5
Write Recovery Time	$t_{WR}$	0	—	ns	*6
$\overline{CE1}$ High Pulse Width	$t_{CP}$	10	—	ns	
$\overline{WE}$ High Pulse Width	$t_{WHP}$	10	1000	ns	
$\overline{LB}$ , $\overline{UB}$ High Pulse Width	$t_{BHP}$	10	1000	ns	
Data Setup Time	$t_{DS}$	15	—	ns	
Data Hold Time	$t_{DH}$	0	—	ns	
$\overline{OE}$ High to Address Setup Time for Write	$t_{OES}$	0	—	ns	*8
$\overline{OE}$ High to $\overline{CE1}$ Low Setup Time for Write	$t_{OHCL}$	-5	—	ns	*7
$\overline{LB}$ and $\overline{UB}$ Write Pulse Overlap	$t_{BWO}$	30	—	ns	

- \*1 : Maximum value is applicable if  $\overline{CE1}$  is kept at Low without any address change.
- \*2 : Minimum value must be equal or greater than the sum of write pulse width ( $t_{CW}$ ,  $t_{WP}$  or  $t_{BW}$ ) and write recovery time ( $t_{WR}$ ).
- \*3 : Write pulse width is defined from High to Low transition of  $\overline{CE1}$ ,  $\overline{WE}$ ,  $\overline{LB}$  or  $\overline{UB}$ , whichever occurs last.
- \*4 : Applicable for byte mask only. Byte mask setup time is defined to the High to Low transition of  $\overline{CE1}$  or  $\overline{WE}$  whichever occurs last.
- \*5 : Applicable for byte mask only. Byte mask hold time is defined from the Low to High transition of  $\overline{CE1}$  or  $\overline{WE}$  whichever occurs first.
- \*6 : Write recovery time is defined from Low to High transition of  $\overline{CE1}$ ,  $\overline{WE}$ ,  $\overline{LB}$  or  $\overline{UB}$ , whichever occurs first.
- \*7 : If  $\overline{OE}$  is Low after minimum  $t_{OHCL}$ , read cycle is initiated. In other words,  $\overline{OE}$  must be brought to High within 5 ns after  $\overline{CE1}$  is brought to Low.
- \*8 : If  $\overline{OE}$  is Low after new address input, read cycle is initiated. In other words,  $\overline{OE}$  must be brought to High at the same time or before new address valid.

Note : AC Characteristics are measured after following POWER-UP timing.



### (3) Power Down Parameters

Parameter	Symbol	Value		Unit	Note
		Min	Max		
CE2 Low Setup Time for Power Down Entry	$t_{CSP}$	10	—	ns	
CE2 Low Hold Time after Power Down Entry	$t_{C2LP}$	80	—	ns	
$\overline{CE1}$ High Hold Time following CE2 High after Power Down Exit	$t_{CHH}$	300	—	$\mu s$	*
$\overline{CE1}$ High Setup Time following CE2 High after Power Down Exit	$t_{CHS}$	0	—	ns	

\* : Applicable also to power-up.

### (4) Other Timing Parameters

Parameter	Symbol	Value		Unit	Note
		Min	Max		
$\overline{CE1}$ High to $\overline{OE}$ Invalid Time for Standby Entry	$t_{CHOX}$	10	—	ns	
$\overline{CE1}$ High to $\overline{WE}$ Invalid Time for Standby Entry	$t_{CHWX}$	10	—	ns	*1
CE2 Low Hold Time after Power-up	$t_{C2LH}$	50	—	$\mu s$	
$\overline{CE1}$ High Hold Time following CE2 High after Power-up	$t_{CHH}$	300	—	$\mu s$	
Input Transition Time	$t_T$	1	25	ns	*2

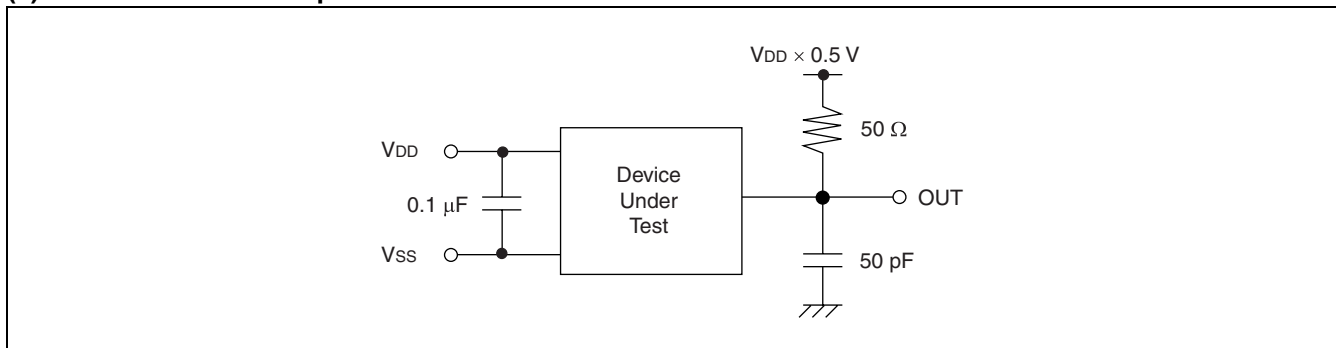
\*1: Some data might be written into any address location if  $t_{CHWX}$  (Min) is not satisfied.

\*2: The Input Transition Time ( $t_T$ ) at AC testing is 5 ns as shown in below. If actual  $t_T$  is longer than 5 ns, it may violate AC specifications of some timing parameters.

### (5) AC Test Conditions

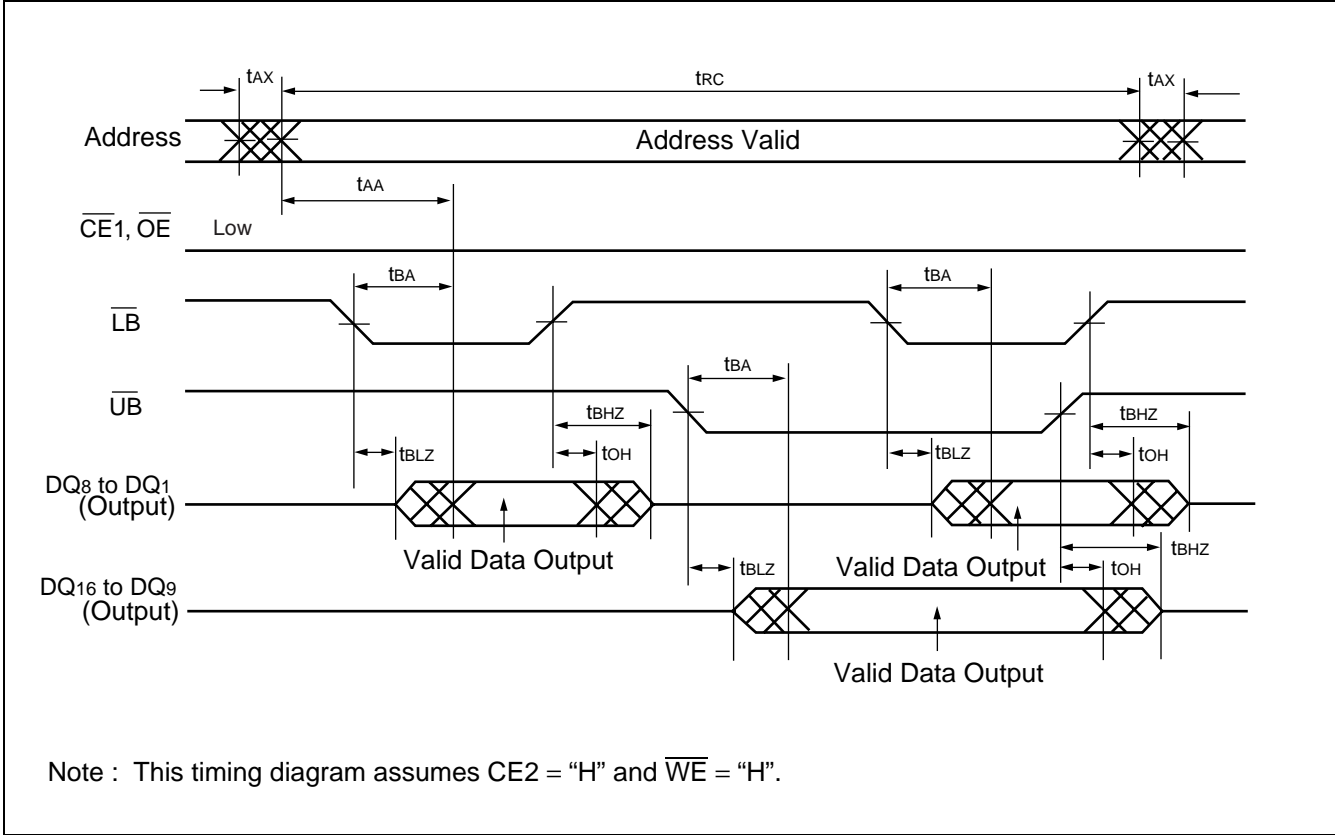
Parameter	Symbol	Conditions	Measured Value	Unit	Note
Input High Level	$V_{IH}$	—	$V_{DD} \times 0.8$	V	
Input Low level	$V_{IL}$	—	$V_{DD} \times 0.2$	V	
Input Timing Measurement Level	$V_{REF}$	—	$V_{DD} \times 0.5$	V	
Input Transition Time	$t_T$	Between $V_{IL}$ and $V_{IH}$	5	ns	

### (6) AC Measurement Output Load Circuit

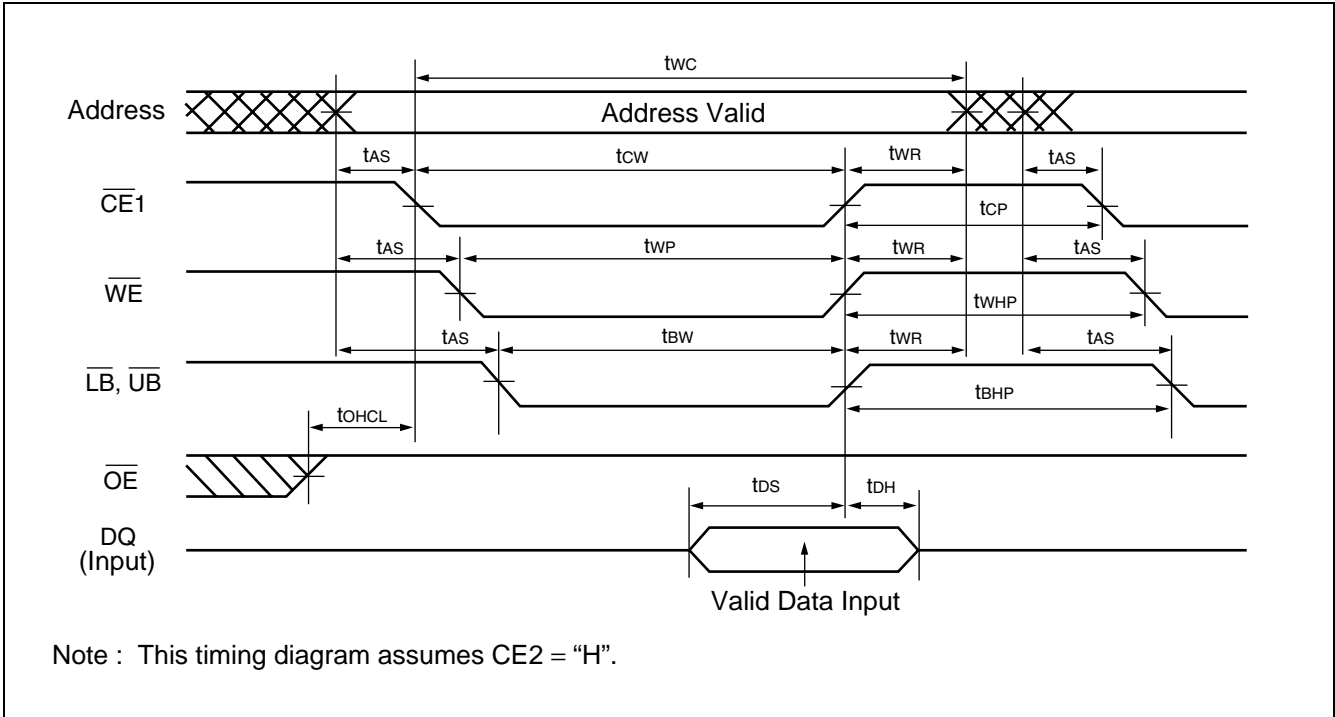




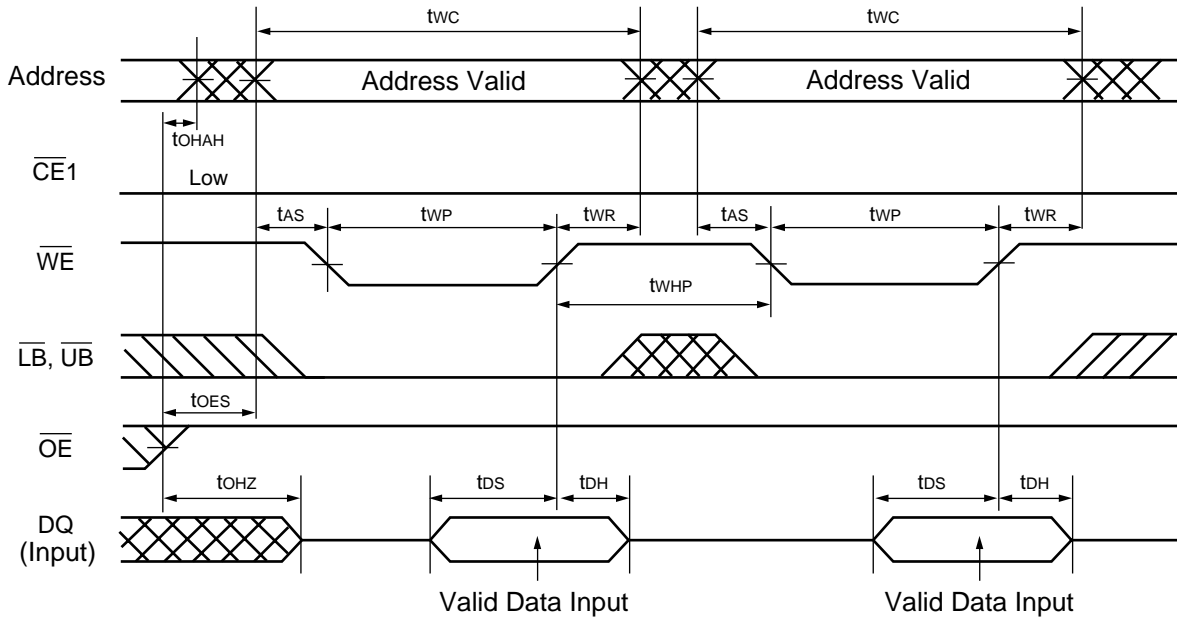
3. READ Timing 3 ( $\overline{\text{LB}}$ ,  $\overline{\text{UB}}$  Byte Access)



4. WRITE Timing 1 (Basic Timing)

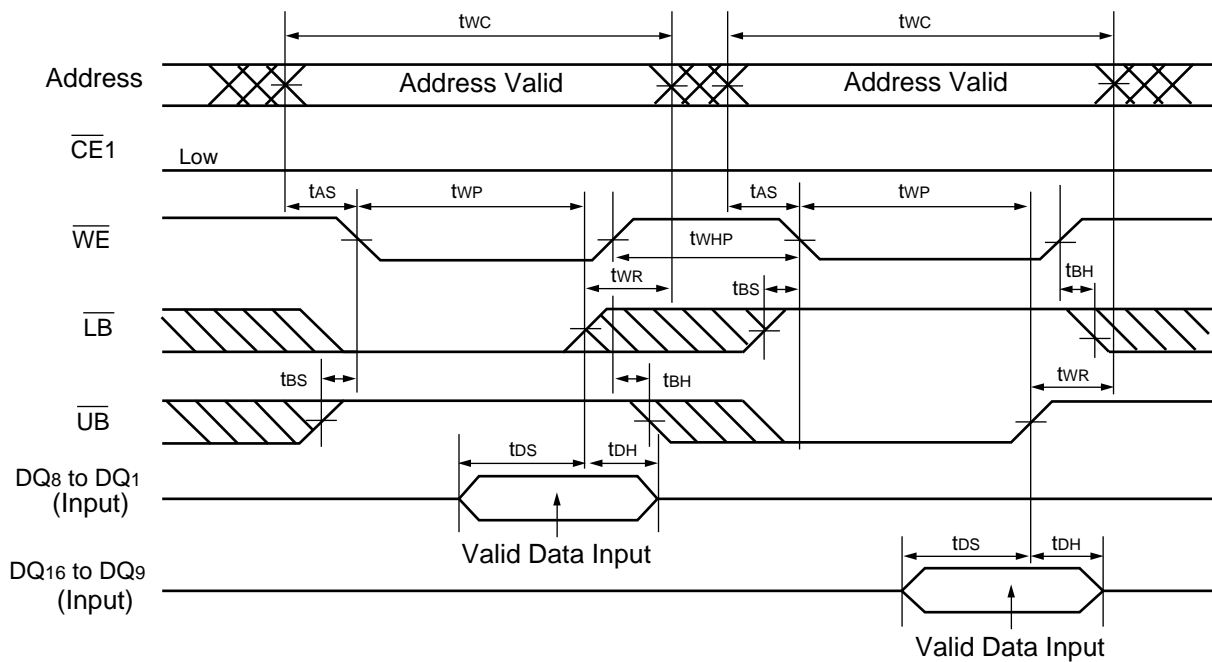


## 5. WRITE Timing 2 ( $\overline{WE}$ Control)



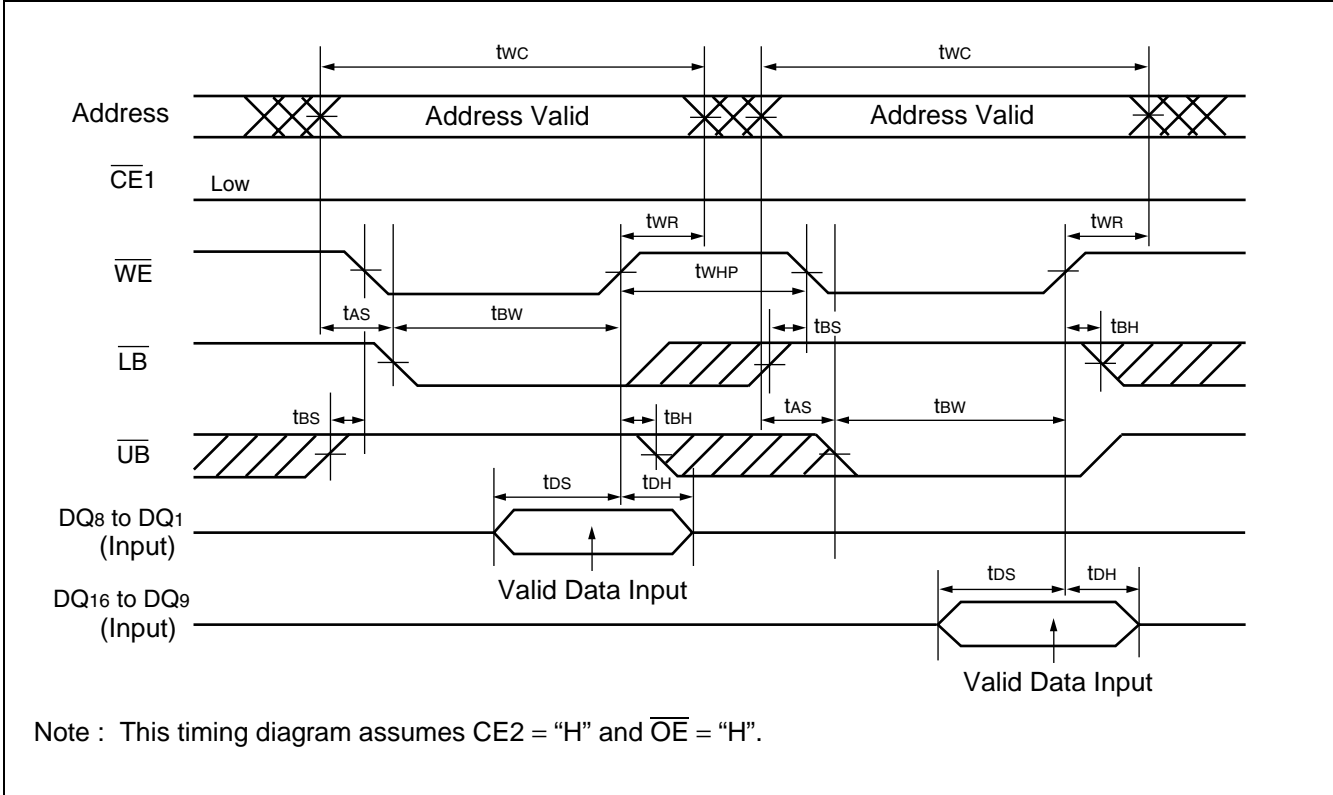
Note : This timing diagram assumes  $CE2 = "H"$ .

## 6. WRITE Timing 3-1 ( $\overline{WE}, \overline{LB}, \overline{UB}$ Byte Write Control)

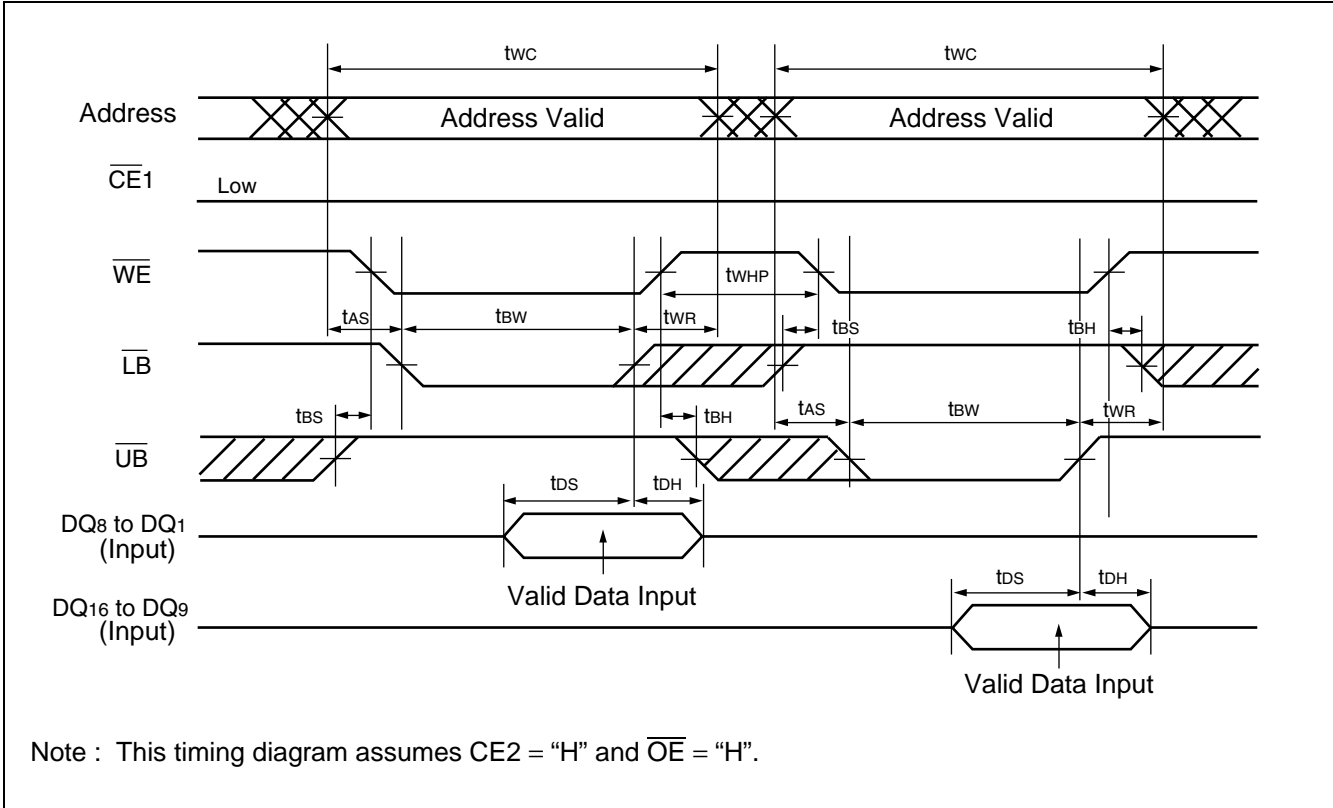


Note : This timing diagram assumes  $CE2 = "H"$  and  $\overline{OE} = "H"$ .

7. WRITE Timing 3-2 ( $\overline{WE}$ ,  $\overline{LB}$ ,  $\overline{UB}$  Byte Write Control)

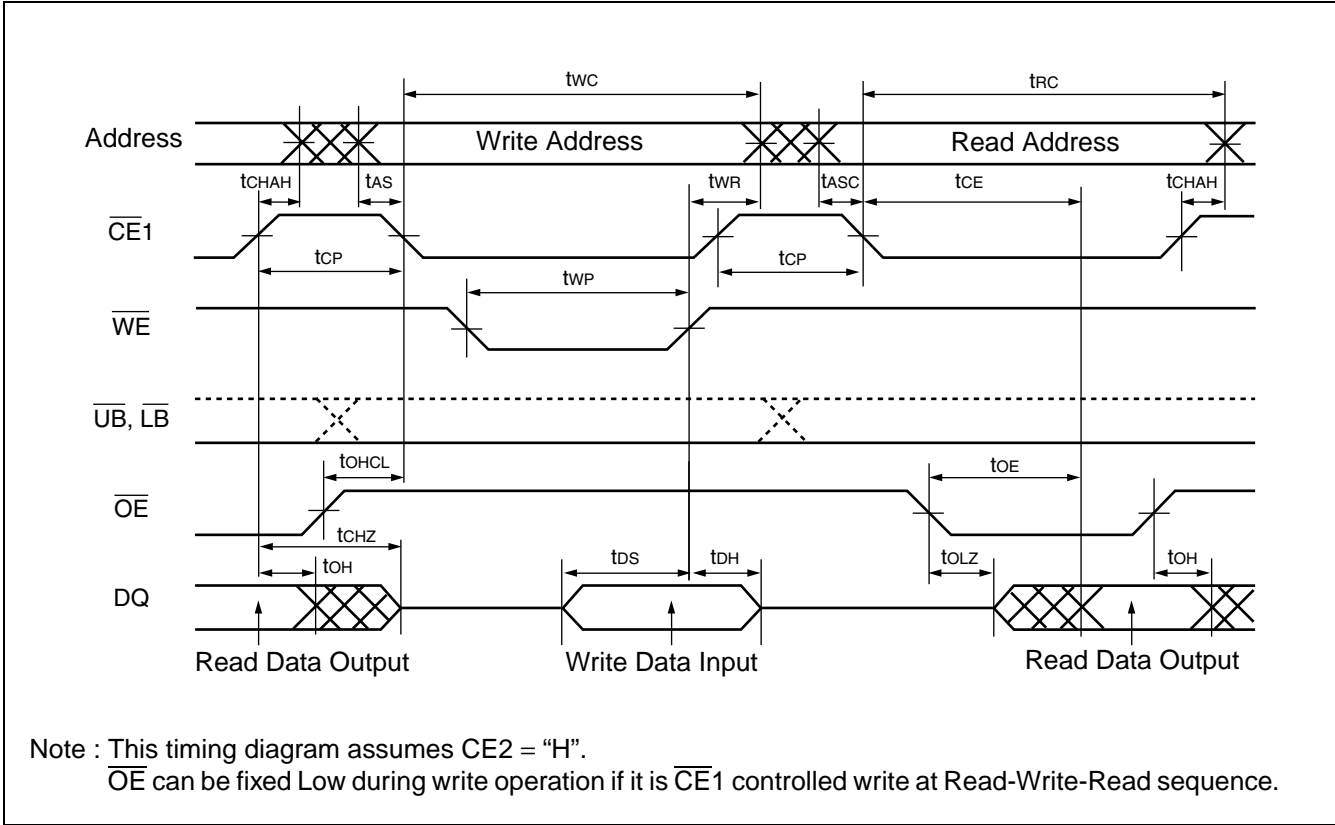


8. WRITE Timing 3-3 ( $\overline{WE}$ ,  $\overline{LB}$ ,  $\overline{UB}$  Byte Write Control)

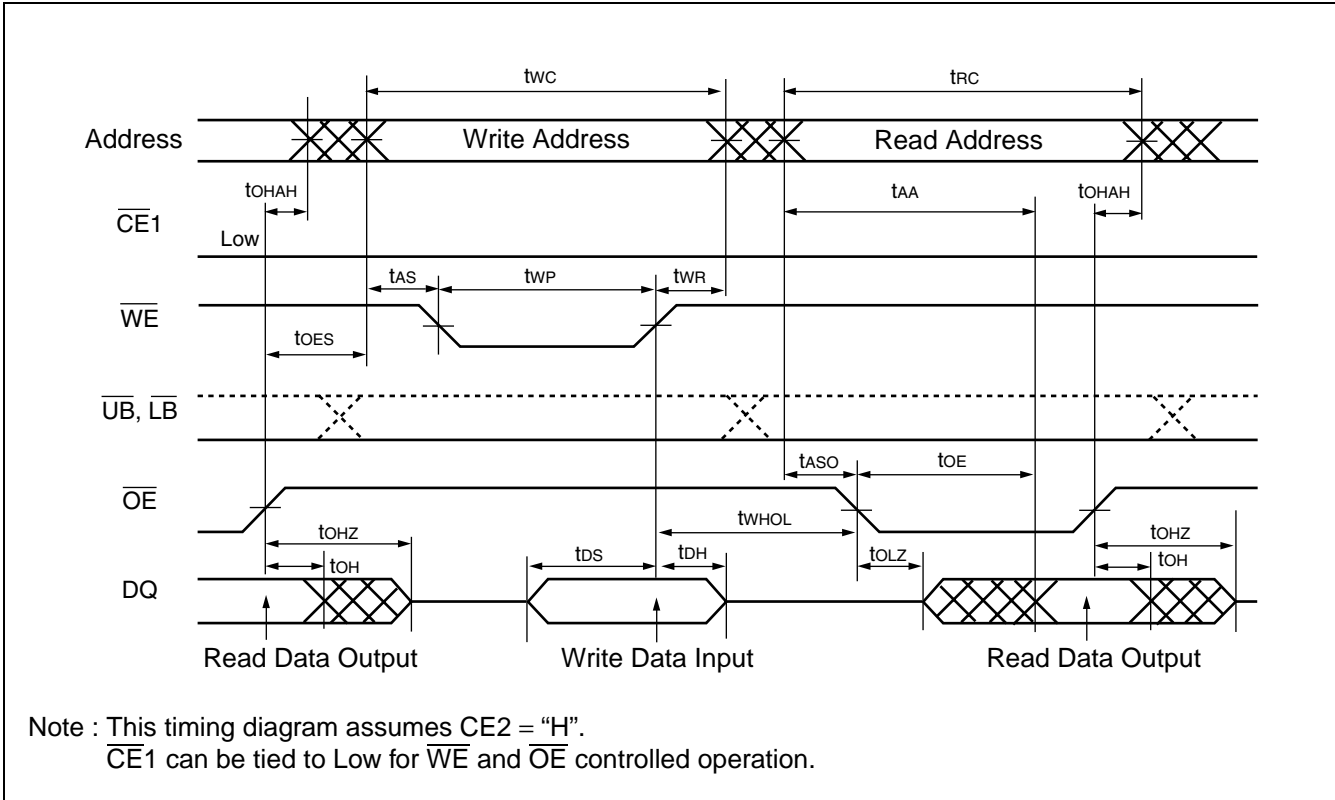




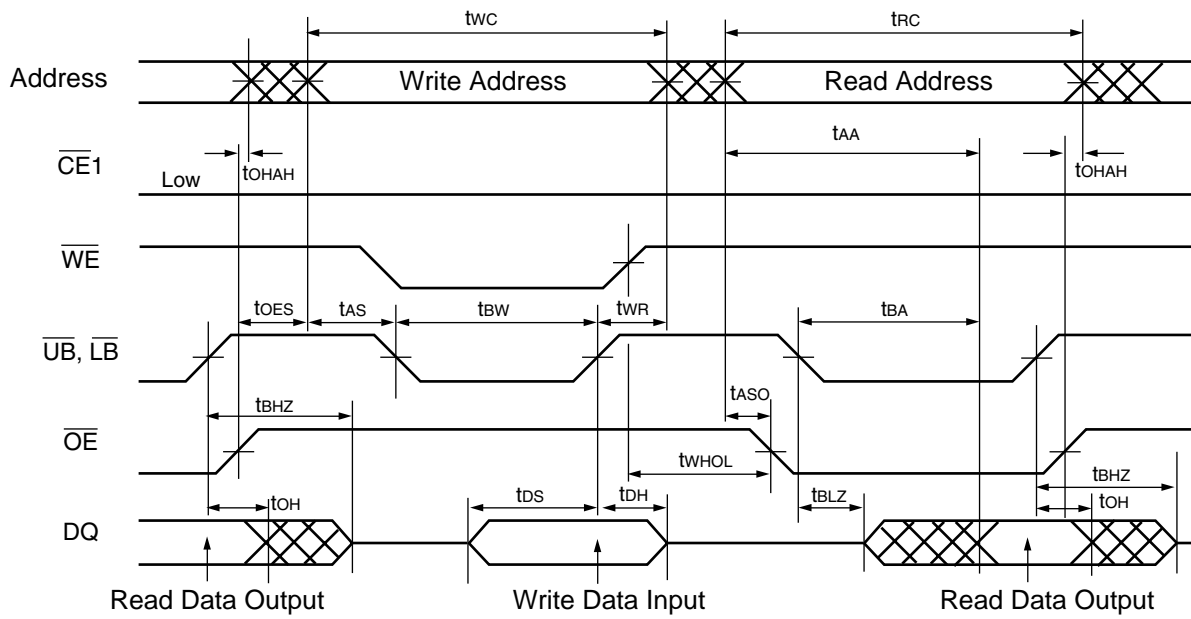
## 11. READ/WRITE Timing 1-2 ( $\overline{CE1}$ , $\overline{WE}$ , $\overline{OE}$ Control)



## 12. READ/WRITE Timing 2 ( $\overline{OE}$ , $\overline{WE}$ Control)



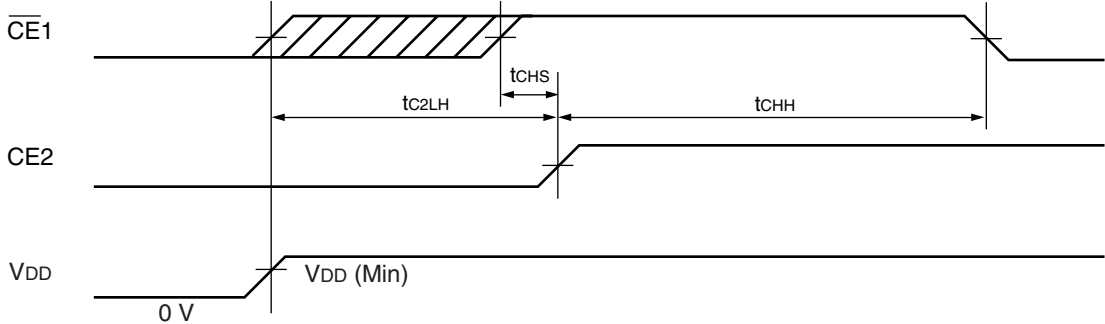
## 13. READ/WRITE Timing 3 ( $\overline{OE}$ , $\overline{WE}$ , $\overline{LB}$ , $\overline{UB}$ Control)



Note : This timing diagram assumes  $CE2 = "H"$ .  
 $\overline{CE1}$  can be tied to Low for  $\overline{WE}$  and  $\overline{OE}$  controlled operation.

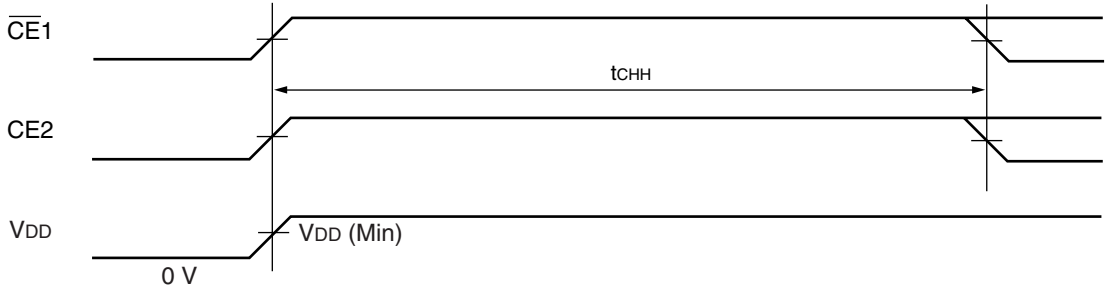


14. POWER-UP Timing 1



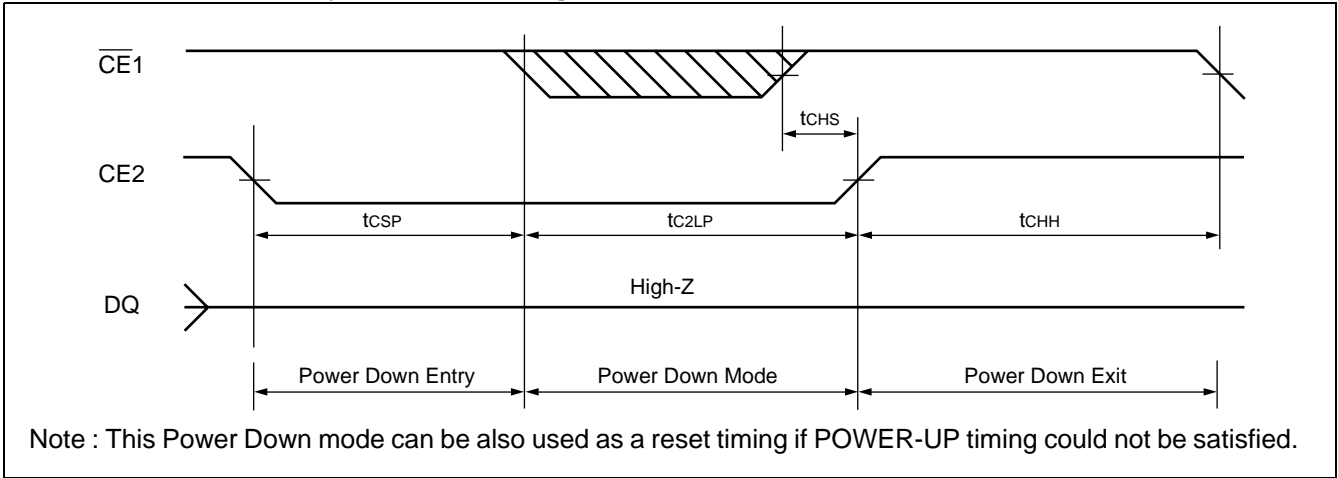
Note :  $t_{C2LH}$  specifies after  $V_{DD}$  reaches specified minimum level.

15. POWER-UP Timing 2

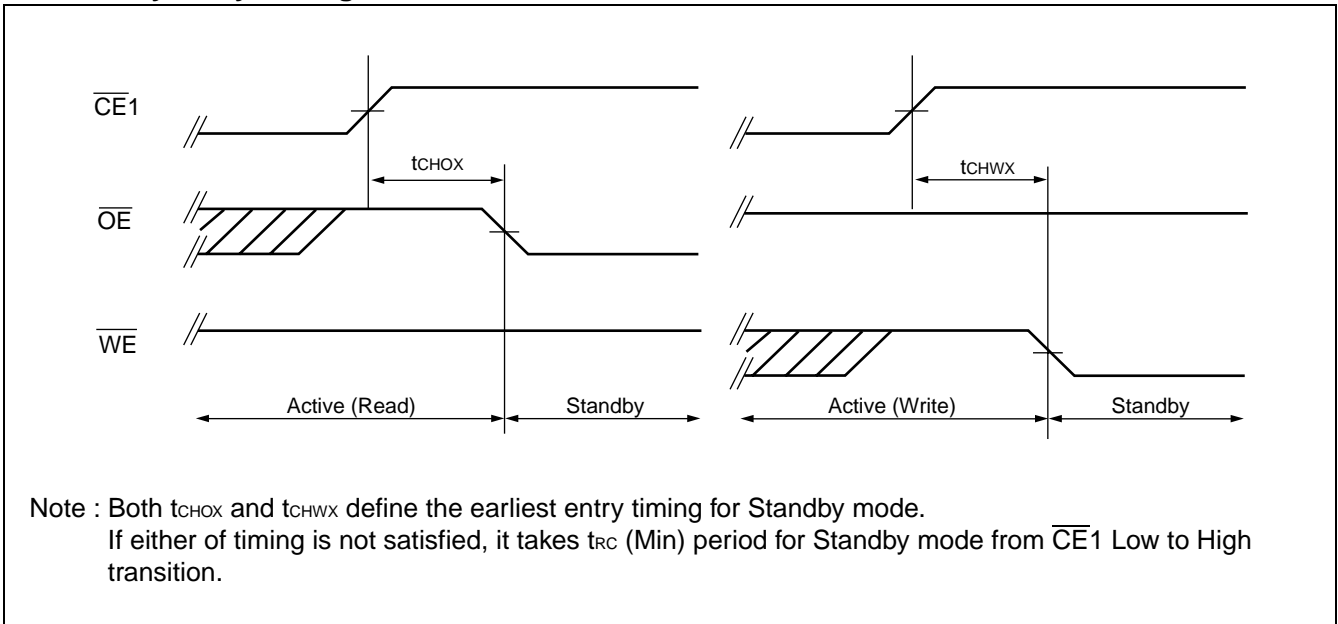


Note :  $t_{CHH}$  specifies after  $V_{DD}$  reaches specified minimum level and applicable to both  $\overline{CE1}$  and CE2.  
If transition time of  $V_{DD}$  (from 0 V to  $V_{DD}(\text{Min})$ ) is longer than 100 ms, POWER-UP Timing#1 must be applied.

## 16. POWER DOWN Entry and Exit Timing



## 17. Standby Entry Timing after Read or Write



## ■ BONDING PAD INFORMATION

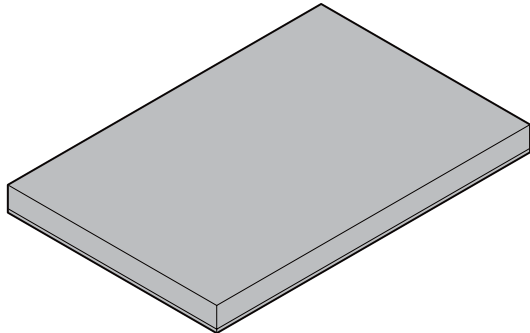
Please contact local FUJITSU representative for pad layout and pad coordinate information.

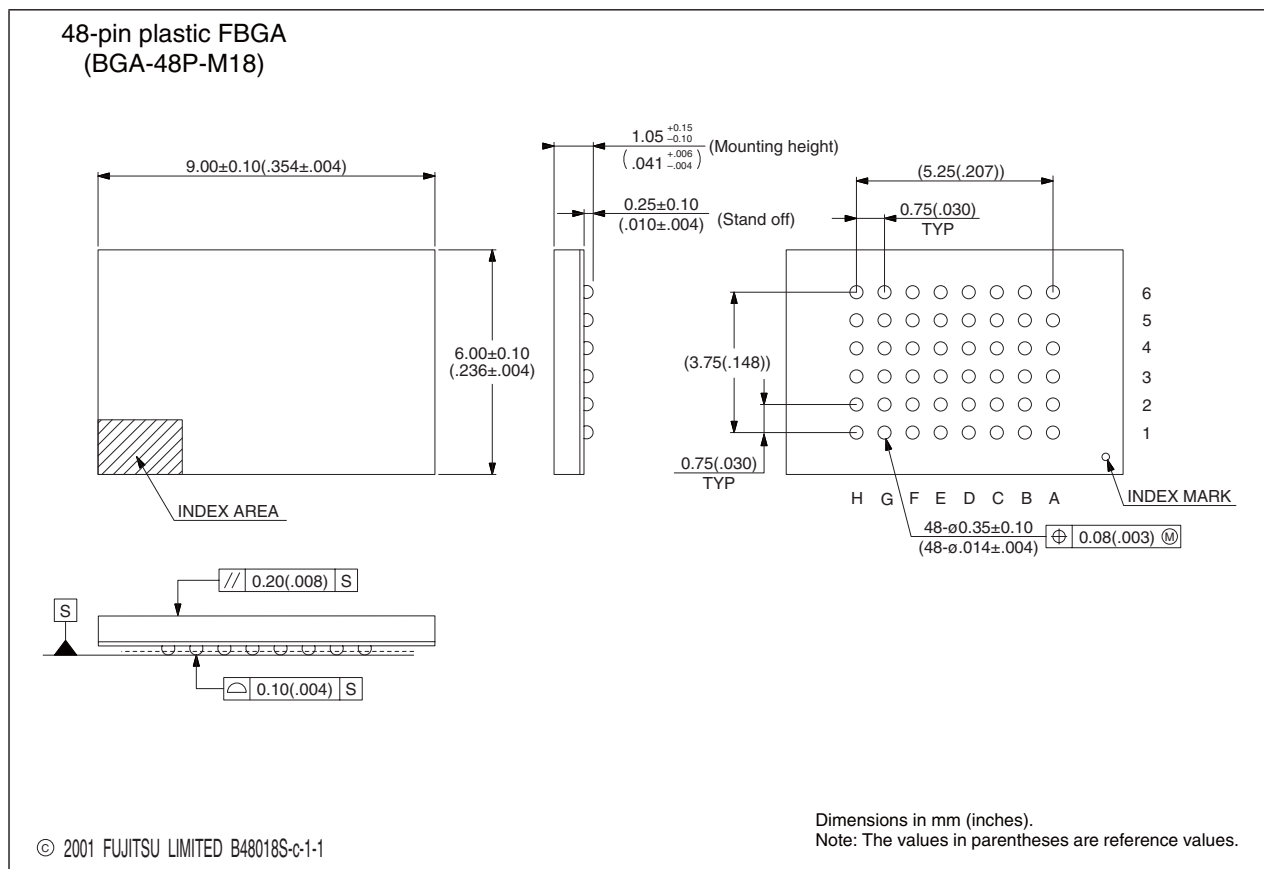
## ■ ORDERING INFORMATION

Part No.	Shipping Form/Package	Remarks
MB82D01181E-60LWT	Wafer	
MB82D01181E-60LPBN	48-pin plastic FBGA (BGA-48P-M18)	SRAM compatible FBGA package $t_{CE} = 60 \text{ ns Max}$

# MB82D01181E-60L

## ■ PACKAGE DIMENSION

<p style="text-align: center;">48-pin plastic FBGA</p>  <p style="text-align: center;">(BGA-48P-M18)</p>	Ball pitch	0.75 mm
	Package width × package length	6.00 × 9.00 mm
	Lead shape	Fine pitch ball
	Sealing method	Plastic mold
	Mounting height	1.20 mm MAX
	Weight	0.10 g



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